AD-A170 731 PLASMA JOINING OF METAL MATRIX COMPOSITES(U) MSNW INC 1/1
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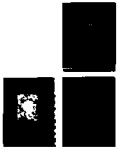

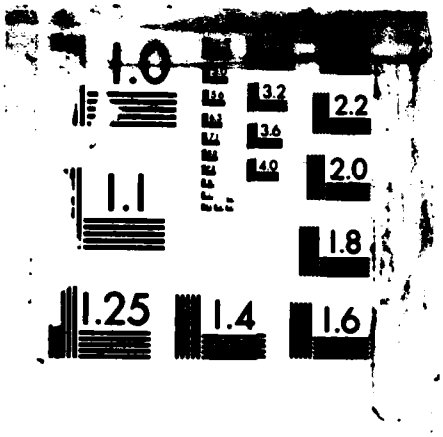

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The microstructural and microchemical changes produced in precomposited 1100 aluminum - 30 wt.% SiC_p, aluminum - 5 wt.% Ti - 30 wt.% SiC_p and aluminum - 3 wt.% Zr - 30 wt.% SiC_p powder filler metals caused by low pressure, transferred arc plasma deposition onto inert substrates are described.

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ABSTRACT

The microstructural and microchemical changes produced in precomposited 1100 aluminum - 30 wt.% SiC_p, aluminum - 5 wt.% Ti - 30 wt.% SiC_p and aluminum - 3 wt.% Zr - 30 wt.% SiC_p powder filler metals caused by low pressure, transferred arc plasma deposition onto inert substrates are described.

EXPERIMENTAL RESULTS

This report describes microstructural and microchemical characterization of low pressure, transferred arc plasma deposits produced on inert substrates using precomposited powder feed (i. e. filler) materials. Powder preparation and low pressure, transferred arc plasma processing parameters were described in a previous report. Also described in the most recent report were the microchemical differences observed between as-produced precomposited powders and those which had been plasma processed and allowed to solidify in free flight. The plasma deposited composite powders described herein impinged on an inert, stainless steel substrate backed by a water-cooled copper chill block to prevent substrate softening and melting. Three types of precomposited powders were used as feed material. These were 1100 aluminum - 30 wt.% SiC_p, aluminum - 5 wt.% Ti - 30 wt.% SiC_p and aluminum - 3 wt.% Zr - 30 wt.% SiC_p.

Figure 1 shows the C and Si microprobe traces across a representative SiC particle in the microstructure of the 1100 aluminum - 30 wt.% SiC_p deposit. The SiC particle showed edge X-ray resolution of 4 microns which was slightly lower than reported previously for the as-produced powder. Corrected X-ray intensity ratios for Si and C are 31:1 which is virtually identical to the

starting powder. The average SiC particle size is similar to that of the starting powder unlike that observed in the composite powder allowed to solidify in free flight where substantial fragmentation of the SiC phase within the composite powder particles was observed. It is concluded that microchemical differences between the starting powders and the dense, solid deposits are minimal for this baseline system.

Figure 2 shows C, Si and Ti microprobe traces near and across a representative SiC particle in the microstructure of the dense aluminum - 5 wt.% Ti - 30 wt.% SiC_p deposit. The Si:C X-ray intensity ratio was 25 in reasonable agreement with the starting powders. The average SiC phase particle size was reduced with respect to the starting powders as previously observed for composite powders allowed to solidify in free flight. Figure 3 shows a second microprobe trace through the same SiC particle. The Si:C ratio was 29.6 in good agreement with the starting powders. For both microprobe traces, Ti-rich phase particles were observed in the matrix alloys unlike the case of the powders allowed to solidify in free flight where the excess titanium was apparently "quenched-in" to the matrix alloy. The slower cooling rate of the solid deposit likely results in Al_3Ti precipitation and growth in the matrix alloy. The most striking feature of the microprobe traces shown in Figures 2 and 3 is the appearance of an apparent Ti-rich reaction zone at the particle/matrix interface as might be expected under relatively slow cooling conditions. The interfacial phase, probably TiC, is both expected and desired to suppress Al_4C_3 formation at the interface. A backscattered electron image of the SiC particle and the paths of the two microprobe traces shown in Figures 2 and 3 is shown in Figure 4. The white second phase visible in the matrix is the Ti-rich phase.

Figure 5 and 6 show the C, Si and Zr microprobe traces across a representative SiC particle in the microstructure of the aluminum - 3 wt.% Zr - 30 wt.% SiC_p deposit and the corresponding backscattered electron image of the SiC particle and trace path, respectively. Similarly, Figures 7 and 8 show C, Si and Zr microprobe traces across a different SiC particle in the same microstructure and the trace path, respectively. (Figures 5 and 6 are at a magnification of 4000X, Figures 7 and 8 at 2000X). The average size of the SiC phase particles was reduced compared to the starting powders as noted above for the Ti-containing matrix alloy. The Si:C X-ray intensity ratios were 33 and 32 for these two particles, which values are similar to the starting materials. A Zr-rich phase, likely Al_3Zr, is observed in the matrix microstructure as in the starting powders. No Zr-rich region was detected at the particle/matrix interface unlike the case for the Ti-containing matrix composition. The thickness of this region is predicted to be substantially below the resolution limit of the microprobe for the short plasma residence times employed in this study, however, and even after relatively slow cooling in the deposits may still be below the resolution limit.

Thus low pressure, transferred arc plasma processing had no detrimental effect on either the baseline or reactive metal-containing matrix alloy composite compositions. (The reduction in SiC particle size in the plasma deposited material is not considered detrimental). The possible formation of protective, reactive metal rich interfacial phases may be quite beneficial to the properties of the composite deposits. Similar analyses of composite deposits produced on aluminum-SiC_p composite substrate base plates will be initiated shortly.

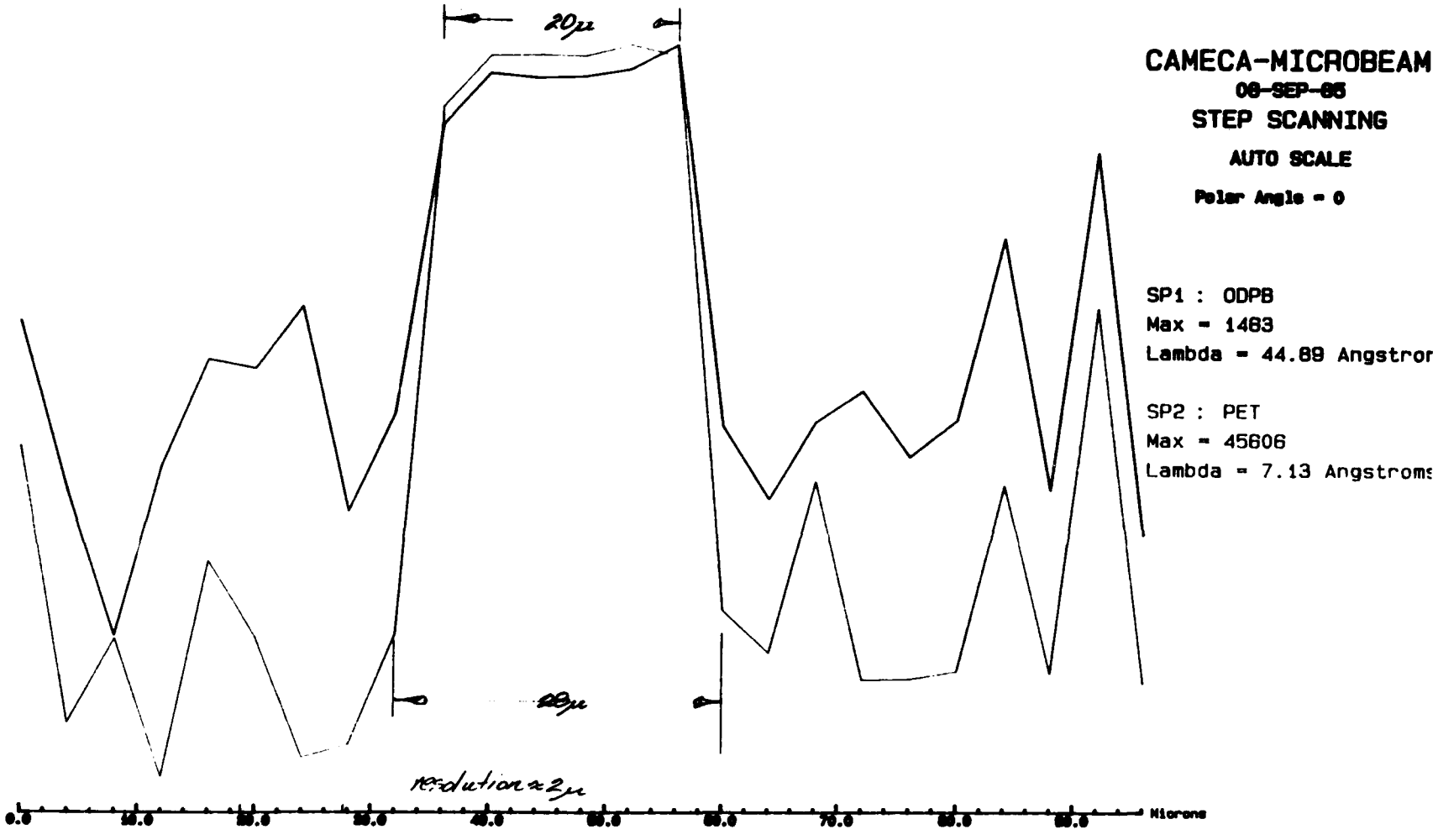

Figure 1.

#2 Sprayed on Plate ; 1100 + 30% SiC ; Ukα ; Si Kα ; 15KV ; 10 nA ; no Photo

#2

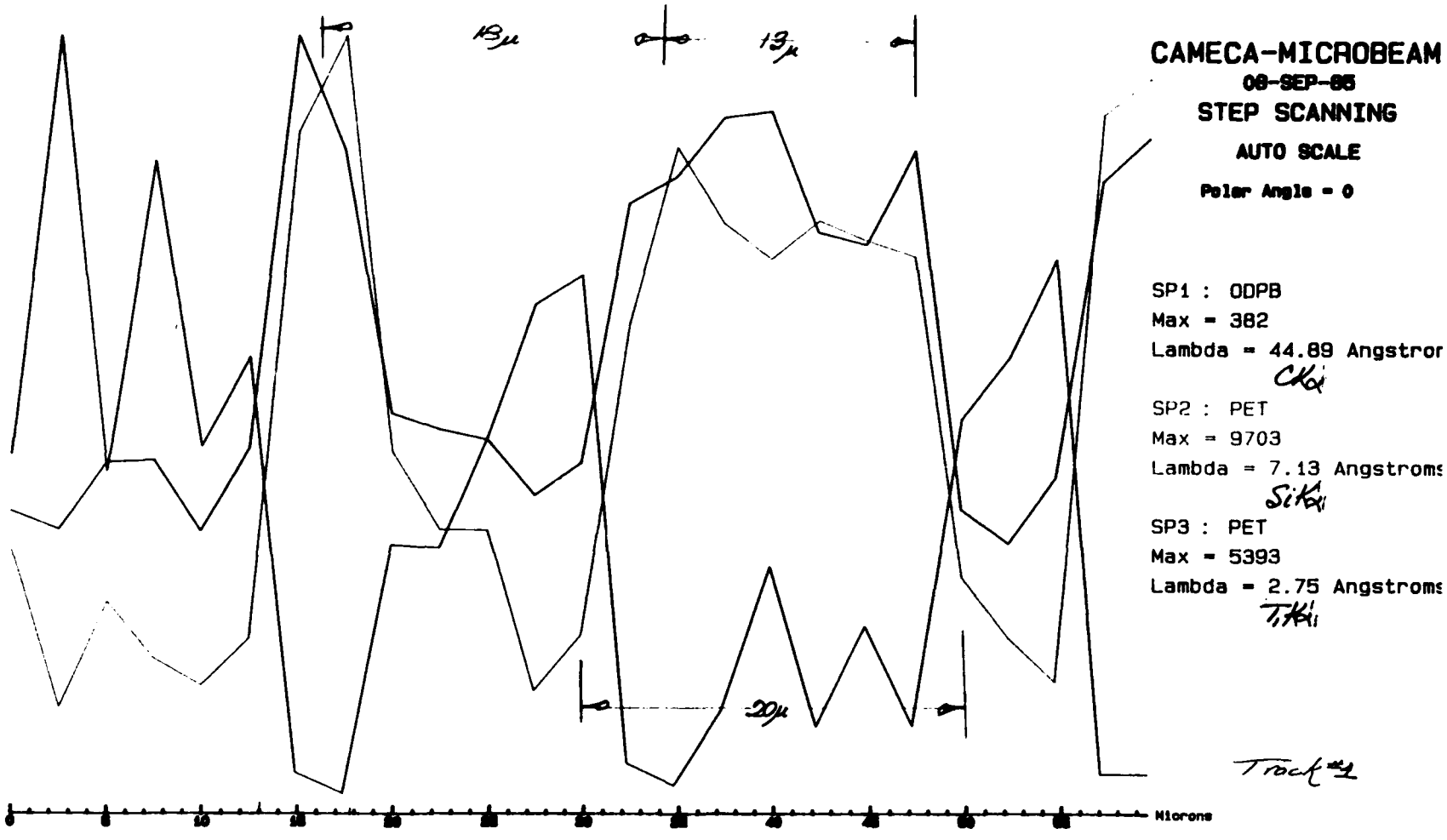

Figure 2.

#2 Sprayed on Plate; Al 5Ti +30% SiC; CKα; SiKα; TiKα; 15KV; 2.1 nA mp; Backscattered electron; mag = 2000X #2

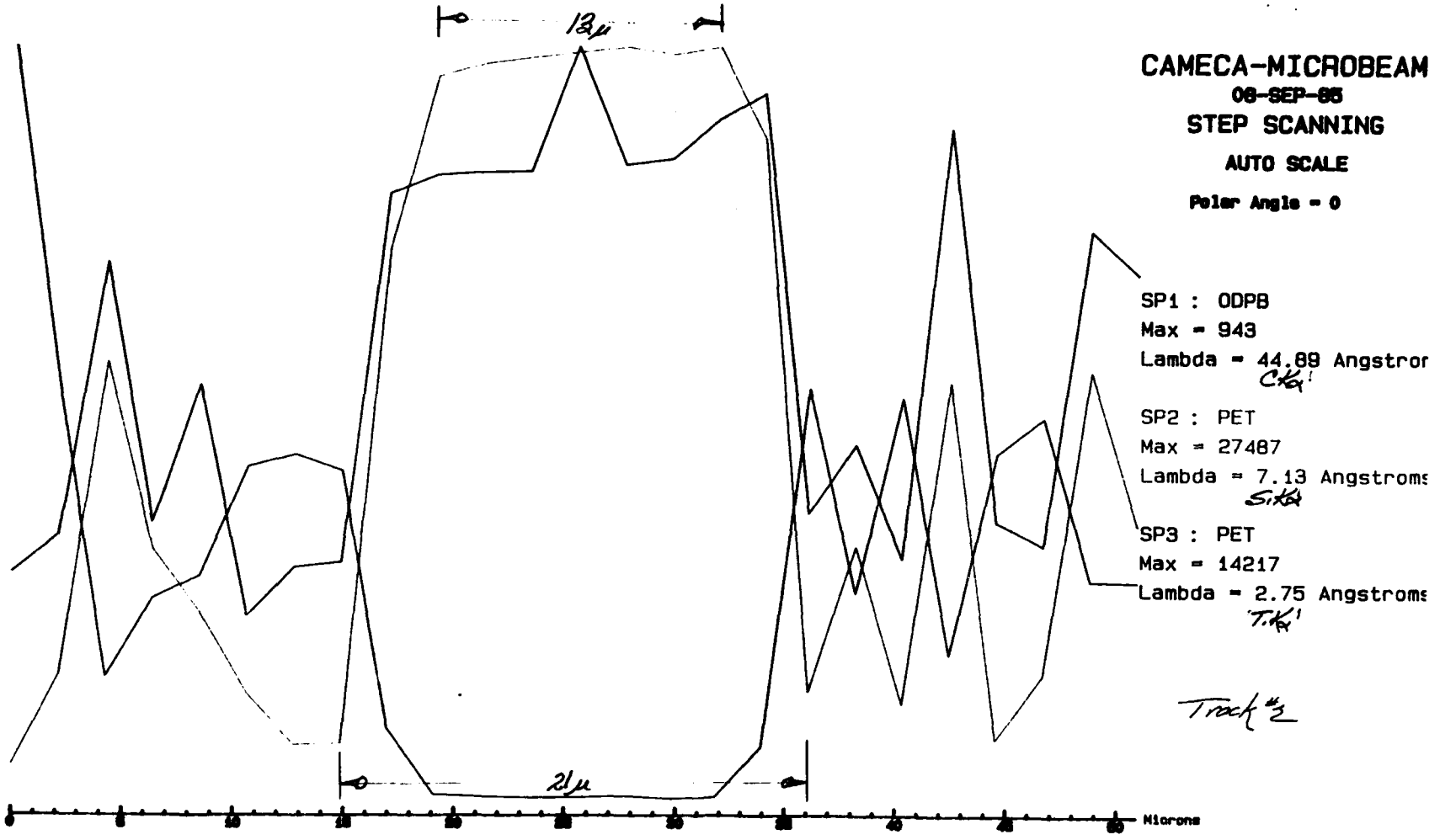

Figure 3.

#2 Sprayed on flake; Al 5Ti + 30% SiC; CKα; SiKα; TiKα; 15Kv; 5.9 namp; Backscattered electron; mag = 2000X

Figure 4. Backscattered electron image showing the paths of the microprobe traces shown in Figures 2 and 3.

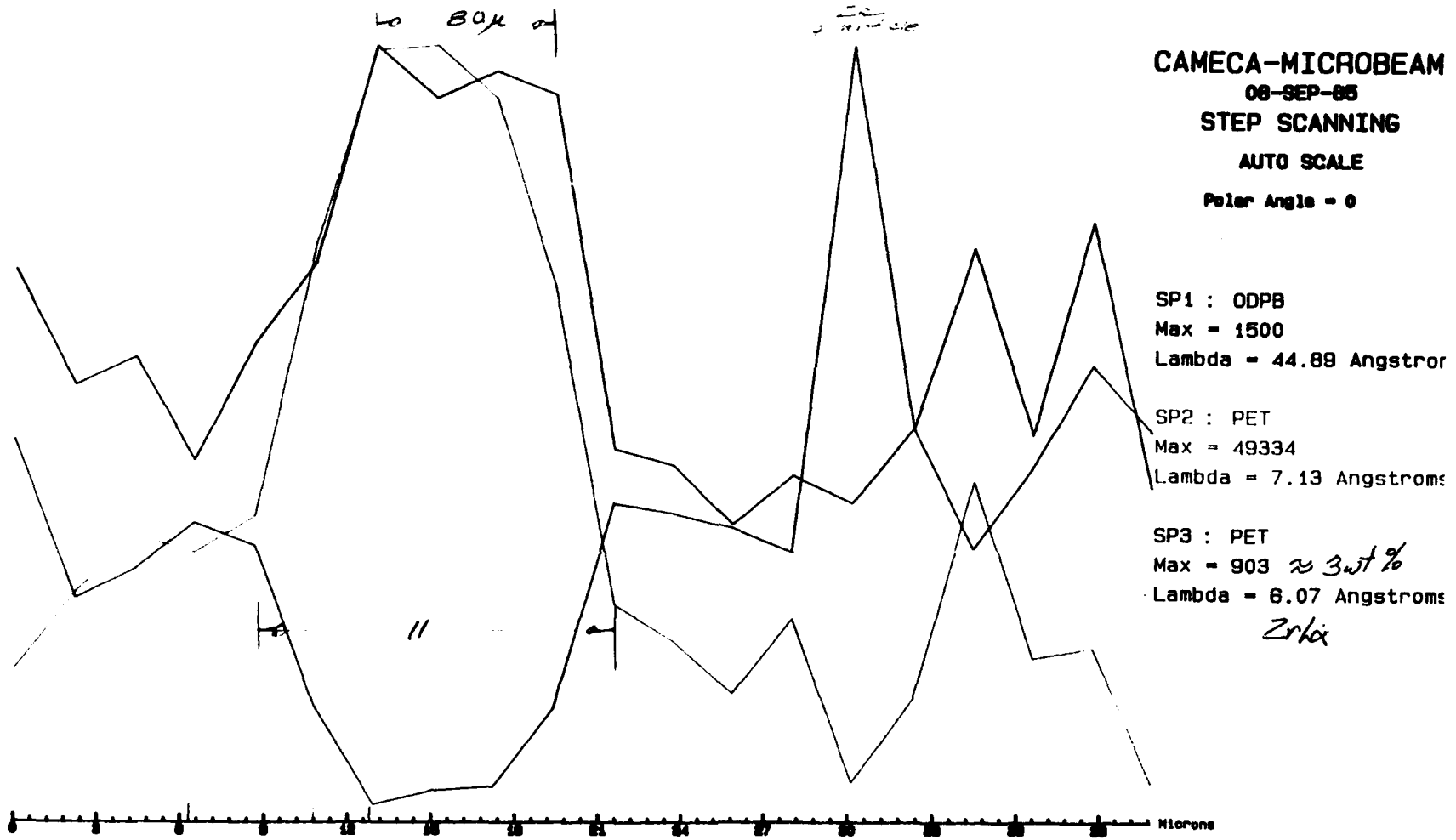

Figure 5.

Track #1

#2 Sputtered on Plate: Al 3Zr+30% SiC; SiKα; SiKα; ZrLα; 15Kv; 10nA; Backscattered electron; mag= 4000x #2

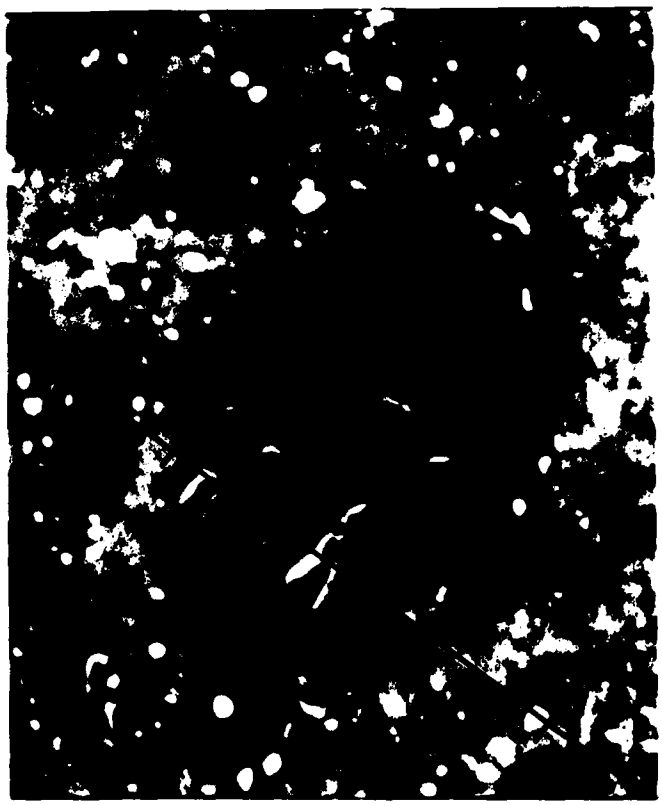

Figure 6. Backscattered electron image showing the path of the microprobe traces shown in Figures 5.

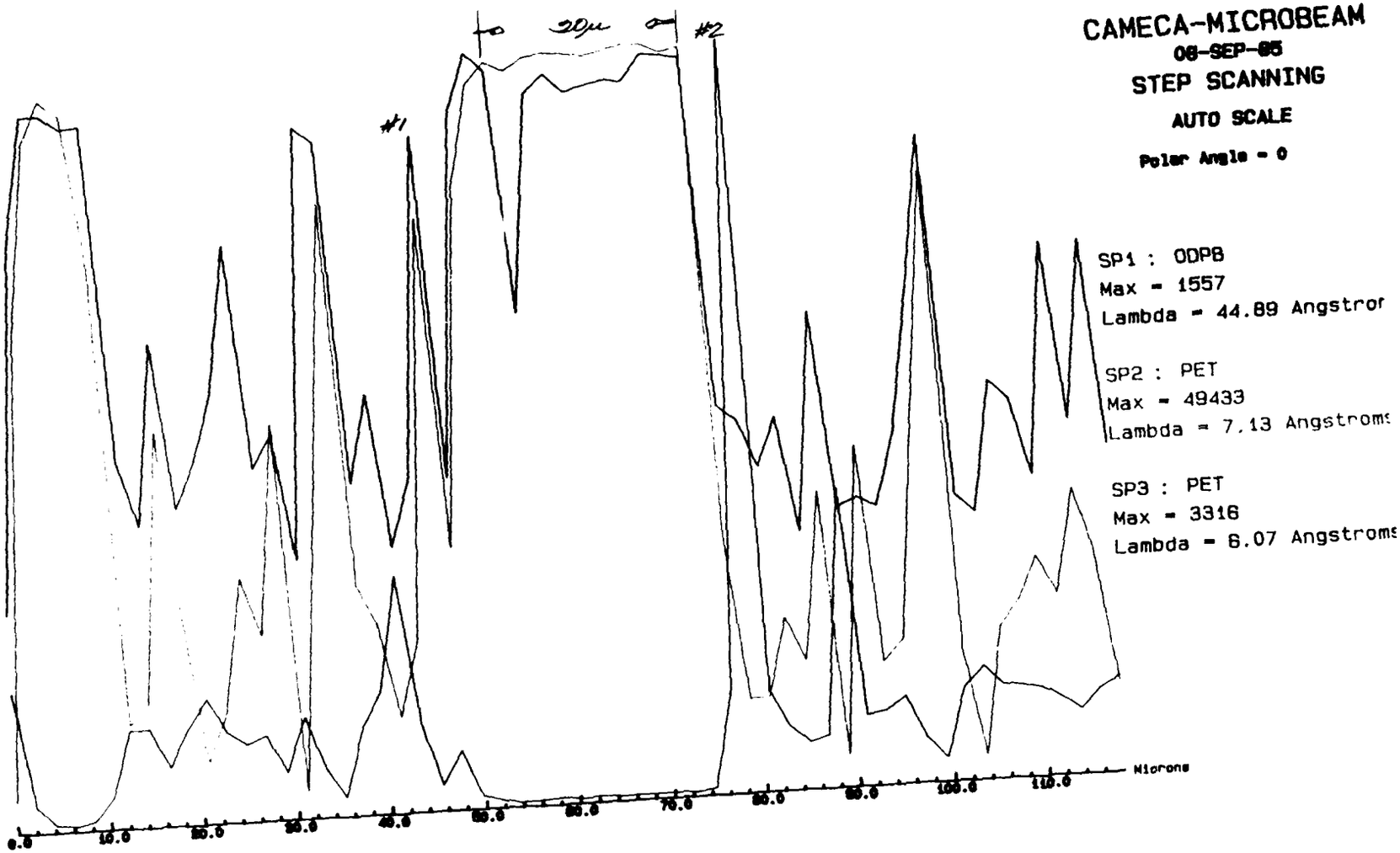

Figure 7.

Track #2

#2 : Imaged on Mate; Ac 32r+20%Si,C; Cpx; Silk; Zrox; 15KV; 1nA min; Backscattered electron; Mag = 200x #2

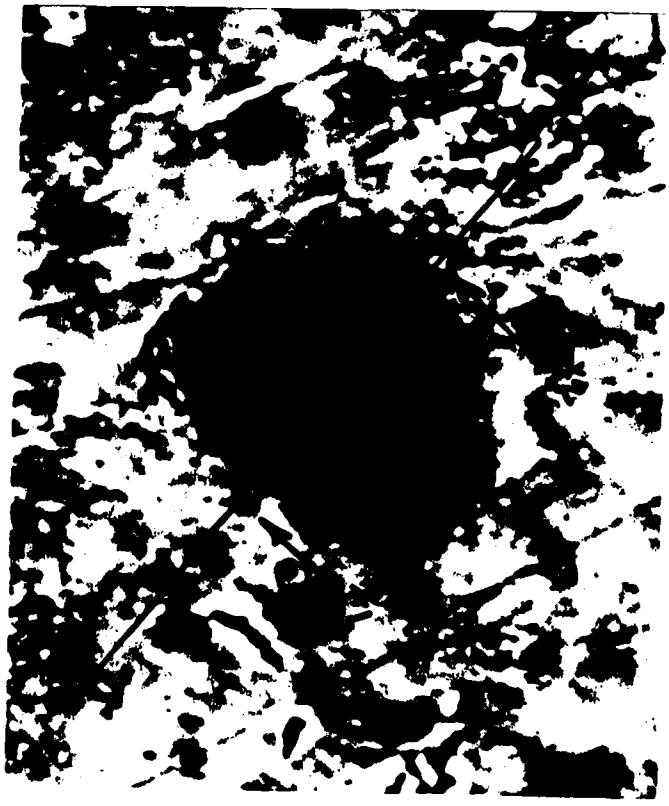

Figure 8. Backscattered electron image showing the path of the microprobe traces shown in Figures 7.

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